

PATENT

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What is claimed is:

1. A method for removing a substrate from a plating cell, comprising:
removing the substrate from a plating solution contained in the plating cell;
applying a plating bias to a plating surface of the substrate during the removing step; and
controlling the plating bias to maintain a constant current density across an immersed portion of the plating surface during the removing step.
2. The method of claim 1, wherein controlling comprises using at least one of a current control and a voltage control system to maintain the constant current density.
3. The method of claim 2, wherein the constant current density is between about 0.5 mA/cm² and about 3 mA/cm².
4. The method of claim 1, wherein removing further comprises rotating the substrate during the removing.
5. The method of claim 4, wherein removing further comprises tilting the substrate such that the plating surface is positioned at an angle with respect to horizontal.
6. The method of claim 1, wherein the plating bias has a voltage of between about 0.3 volts and about 5 volts.
7. The method of claim 1, wherein removing further comprises rotating the substrate between about 5 rpm and about 60 rpm.
8. A method for removing a substrate from a plating solution, comprising:
moving the substrate out of the plating solution;
rotating the substrate during the moving;

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- tilting the substrate to a tilt angle during the removing; and
applying a forward bias to the substrate during the moving.
9. The method of claim 8, wherein tilting the substrate comprises maintaining a constant tilt angle during the moving.
10. The method of claim 8, wherein tilting the substrate comprises at least one of increasing or decreasing the tilt angle during the moving.
11. The method of claim 8, further comprising controlling the application of the forward bias to maintain a constant current density across an immersed portion of the substrate during the moving.
12. The method of claim 11, wherein controlling the forward bias comprises using a current controller.
13. The method of claim 11, wherein controlling the forward bias comprises using a time dependent controller.
14. The method of claim 8, wherein the forward bias generates a current density on a surface of the substrate of between about 0.5 mA/cm^3 and about 3 mA/cm^3 .
15. The method of claim 8, wherein the substrate is rotated between about 10 rpm and about 100 rpm during the moving.
16. The method of claim 8, wherein the forward bias is configured to generate a plating rate sufficient to overcome etching of a layer deposited on the substrate.

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17. A method for removing a substrate from a processing fluid contained in a processing cell, comprising:

tilting the substrate to a tilt angle;

rotating the substrate;

moving the substrate upward out of the processing fluid; and

applying an electrical removal bias configured to generate a constant current density across a substrate surface during the moving of the substrate out of the processing fluid.

18. The method of claim 17, wherein the tilting, rotating, and the upward movement are conducted simultaneously.

19. The method of claim 18, wherein the tilt angle is between about 5° and about 30°.

20. The method of claim 18, wherein the substrate is rotated at between about 20 rpm and about 60 rpm.

21. The method of claim 17, wherein the upward movement has a duration of between about 0.5 seconds and 2 seconds.

22. The method of claim 18, applying the removal bias comprises applying a constant current density across an immersed surface of the substrate of between about 0.5 mA/cm³ and about 4 mA/cm³ to the surface of the substrate.

23. The method of claim 17, wherein applying the removal bias comprises generating a constant current density of between about 1.5 mA/cm³ and about 3 mA/cm³ across an immersed surface of the substrate.

24. The method of claim 17, wherein applying the removal bias comprises applying a voltage of between about 0.4 volts and about 4 volts.

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25. The method of claim 17, wherein applying the removal bias further comprises maintaining a constant current density across an immersed surface area of the substrate during the upward movement of the substrate out of the processing fluid.

26. A method for removing a semiconductor substrate from an electrochemical plating solution, comprising:

tilting the substrate to an angle with respect to horizontal;

rotating the substrate at a rotation rate of between about 20rpm and about 60rpm;

vertically moving the substrate out of the plating solution; and

applying a forward bias to an immersed surface of the substrate during the vertically moving.

27. The method of claim 26, wherein the forward bias is adjusted during the vertical moving to generate a constant current density across an immersed surface area of the substrate.

28. The method of claim 26, wherein the tilting, rotating, moving, and applying a forward bias are conducted simultaneously.